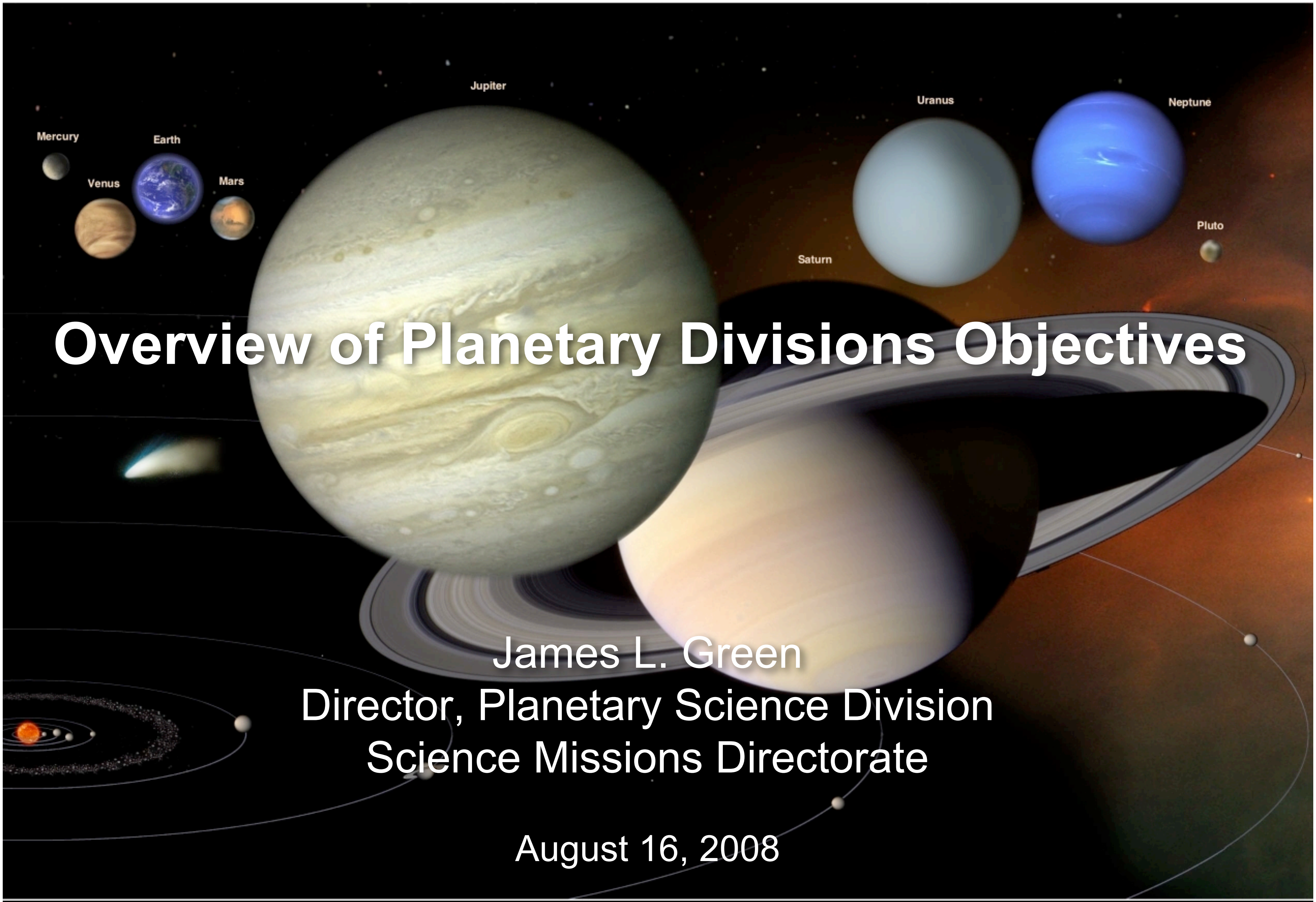


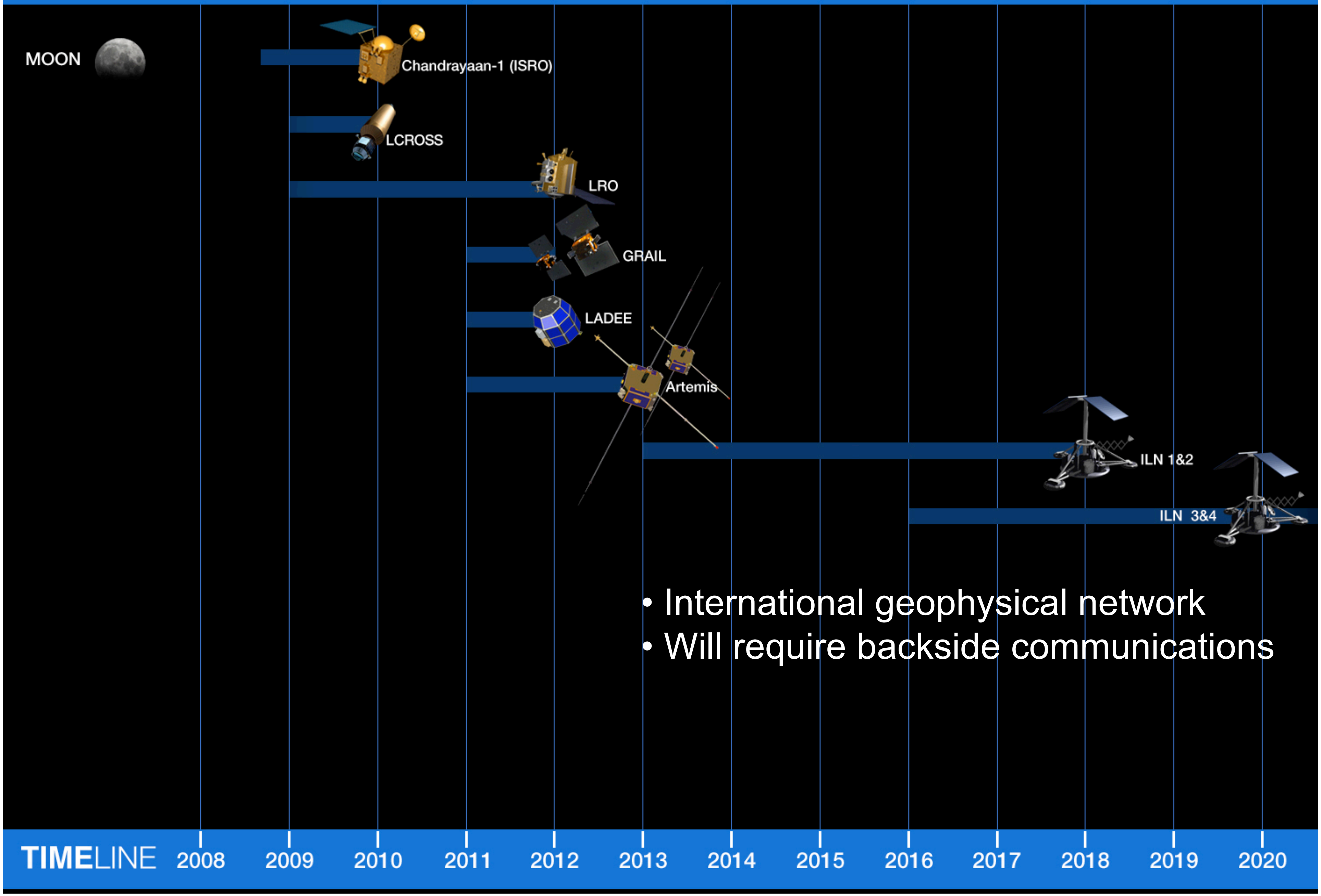
Overview of Planetary Divisions Objectives

James L. Green
Director, Planetary Science Division
Science Missions Directorate

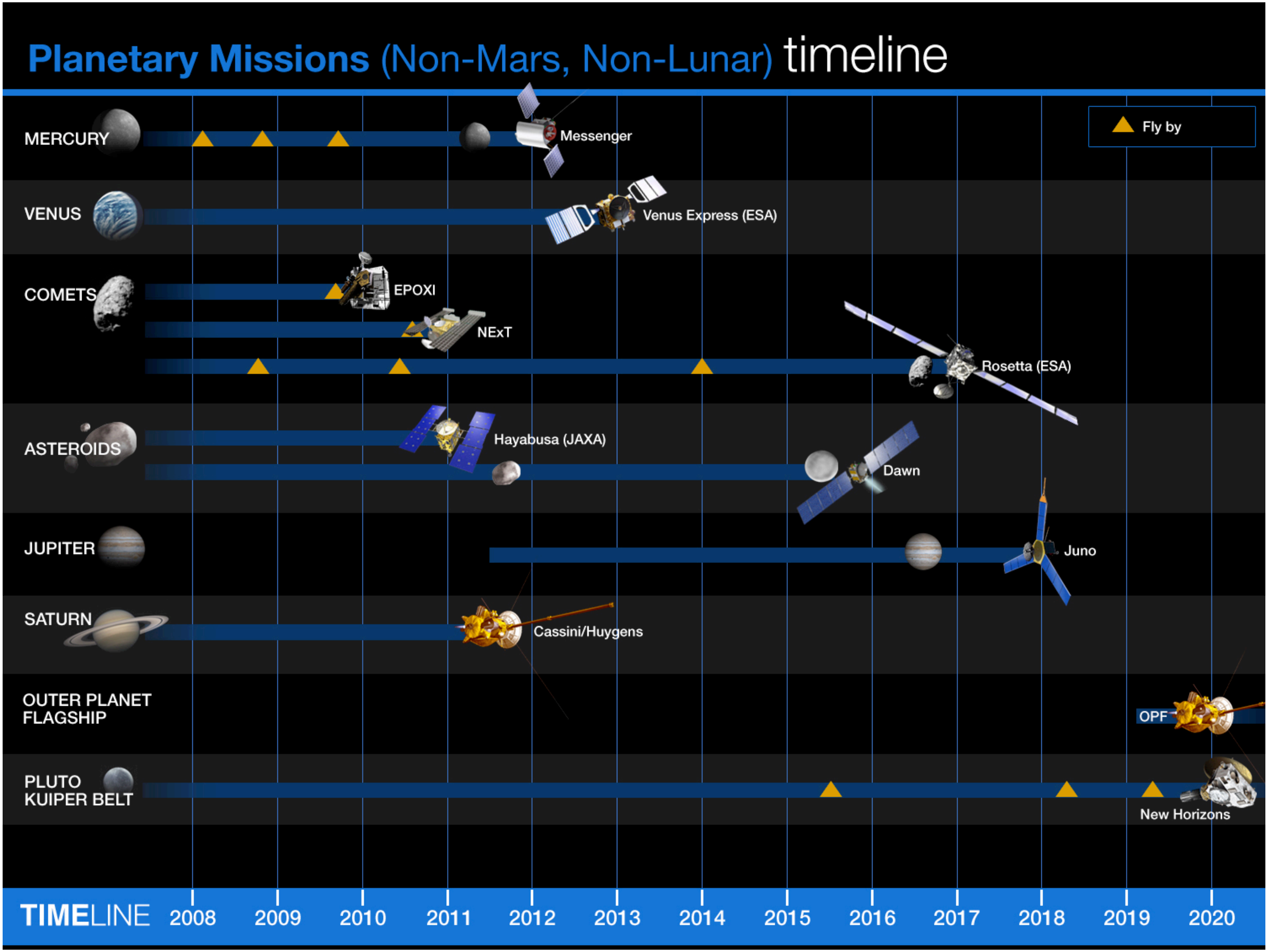
August 16, 2008

Assessment of NASA's
Mars Architecture 2007-2016
EXPLORATION
MOON
New Frontiers
in Solar System
Exploration
NASA's
Planetary Science
Advance scientific knowledge of the origin and
history of the solar system, the potential for life
elsewhere, and the hazards and resources
present as humans explore space
"Flyby, Orbit, Land, Rove, and Return Samples"

Lunar Mission timeline



- International geophysical network
- Will require backside communications

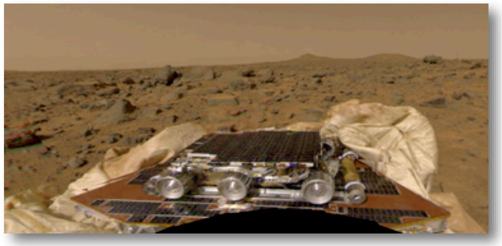


Planetary Missions (Non-Mars, Non-Lunar) timeline
Fly by
MERCURY
Messenger
VENUS
Venus Express (ESA)
COMETS
EPOXI
NExT
Rosetta (ESA)
ASTEROIDS
Hayabusa (JAXA)
Dawn
JUPITER
Juno
SATURN
Cassini/Huygens
OUTER PLANET FLAGSHIP
OPF
PLUTO KUIPER BELT
New Horizons
TIMELINE
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

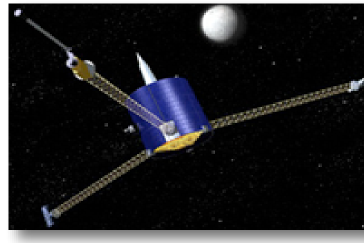
Discovery Program

Completed

Mars evolution:
Mars Pathfinder (1996-1997)



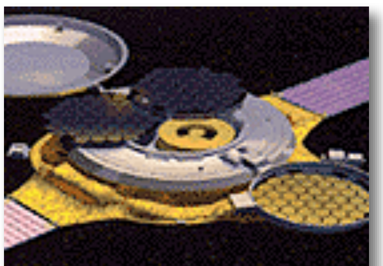
Lunar formation:
Lunar Prospector (1998-1999)



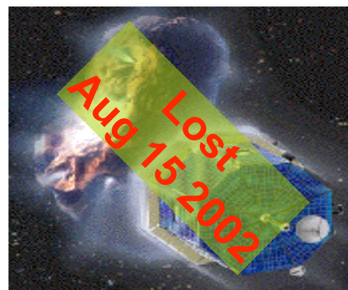
NEO characteristics:
NEAR (1996-1999)

Completed / In Flight

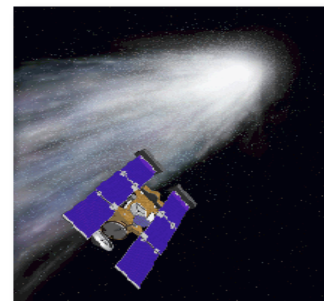
Solar wind sampling:
Genesis (2001-2004)



Comet diversity:
CONTOUR

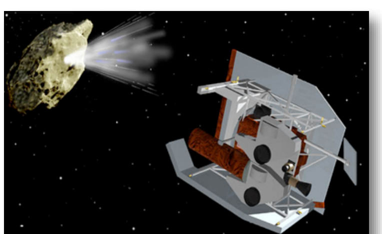


Nature of dust/coma:
Stardust(1999-2006)

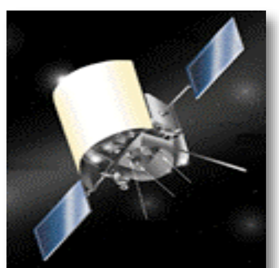


In Flight / In Development

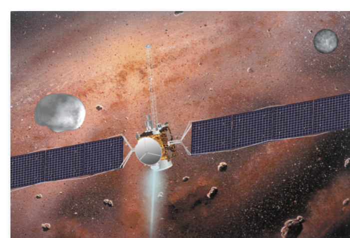
Comet internal structure:
Deep Impact (2005-2006)



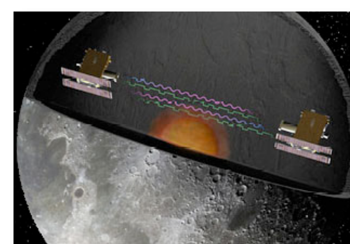
Mercury environment:
MESSENGER (2004-*2012*)



Main-belt asteroids:
Dawn (*2007-2015*)



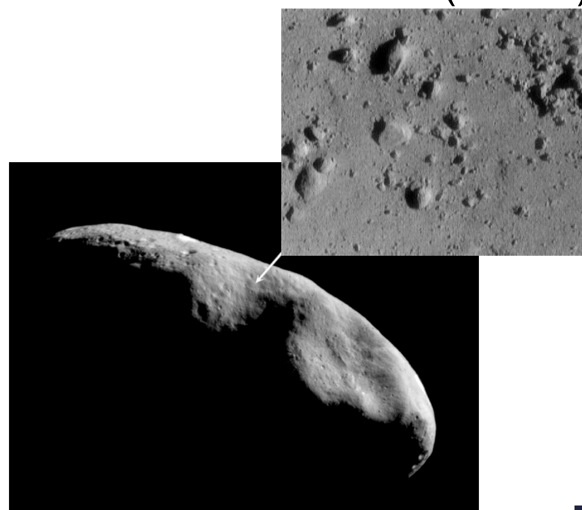
Lunar Internal Structure
GRAIL (*2011-2012*)



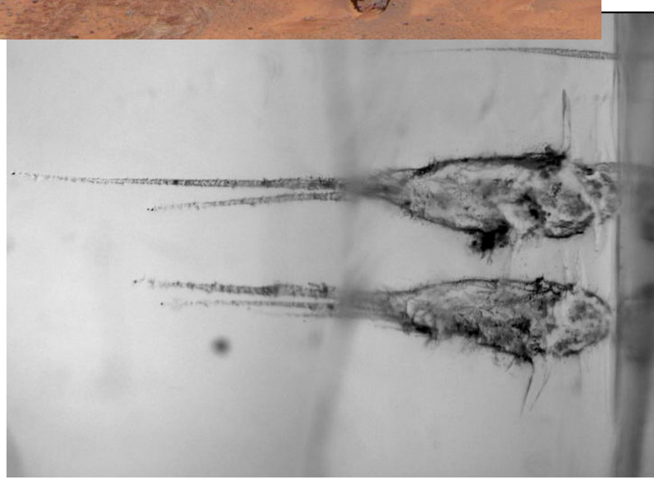
Discovery Program Firsts

First surface rover to explore another planet (Mars Pathfinder)

First to orbit and land on an asteroid (NEAR)

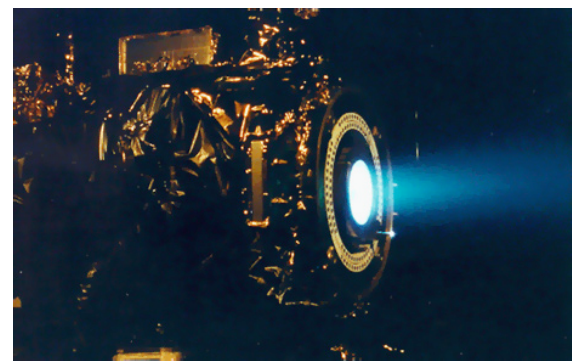


First look inside a comet (Deep Impact)



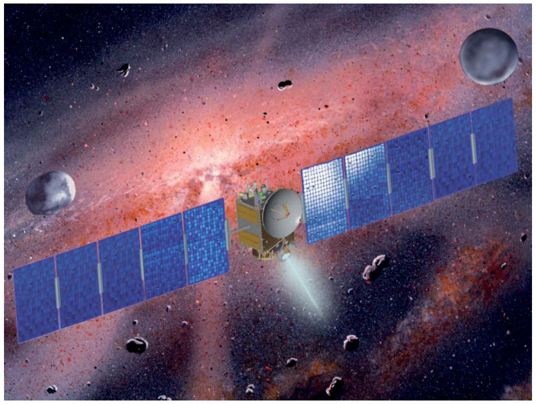
First to collect particles from a comet and return them to Earth (Stardust)

First to collect pieces of the Sun and return them to Earth (Genesis)



First purely science mission powered by Ion propulsion (Dawn)

DAWN



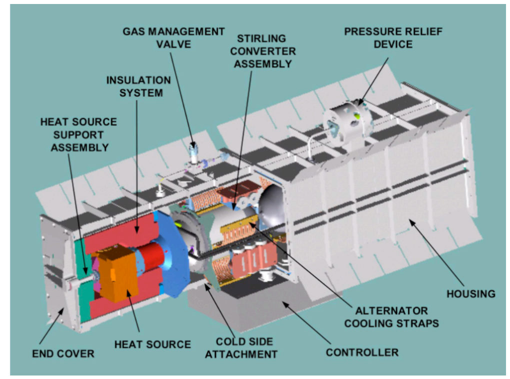
At each asteroid, Dawn will:
Compile a global color map
Compile a topographic map
Map the elemental composition
Map the mineralogical composition
Map the gravity field
Search for moons

DSMCE Program Overview

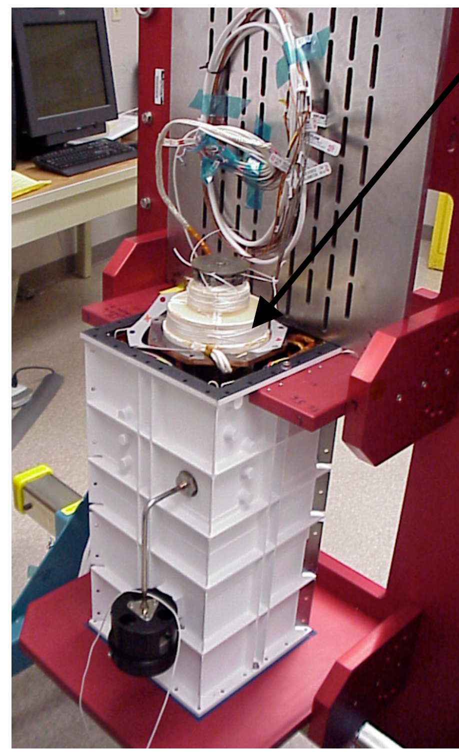
- Discovery-Scout Mission Capability Enhancement
- Program solicited mission concept proposals for small planetary missions that require the ASRG power source
  - Two Stirling Engines with ~140 Watts each (as GFE)
- Intended to foster science exploration in planetary science by missions enabled by ASRG
- Mission design assistance for these 6 month mission concept studies will be offered by NASA
- Selected 9 proposals out of 40 submitted

Advanced Stirling Radioisotope Generator Engineering Unit

- Operation in space and on surface of atmosphere-bearing planets and moons
- Characteristics:
  - ≥14 year lifetime
  - Nominal power : 140 We
  - Mass ~ 20 kg
  - System efficiency: ~ 30 %
  - 2 GPHS (“Pu^{238} Bricks”) modules
  - Uses 0.8 kg Pu^{238}
- Final wiring and connections for ASRG engineering unit underway
- Reliability to be demonstrated by the end of 2009



Lockheed Martin/Sunpower

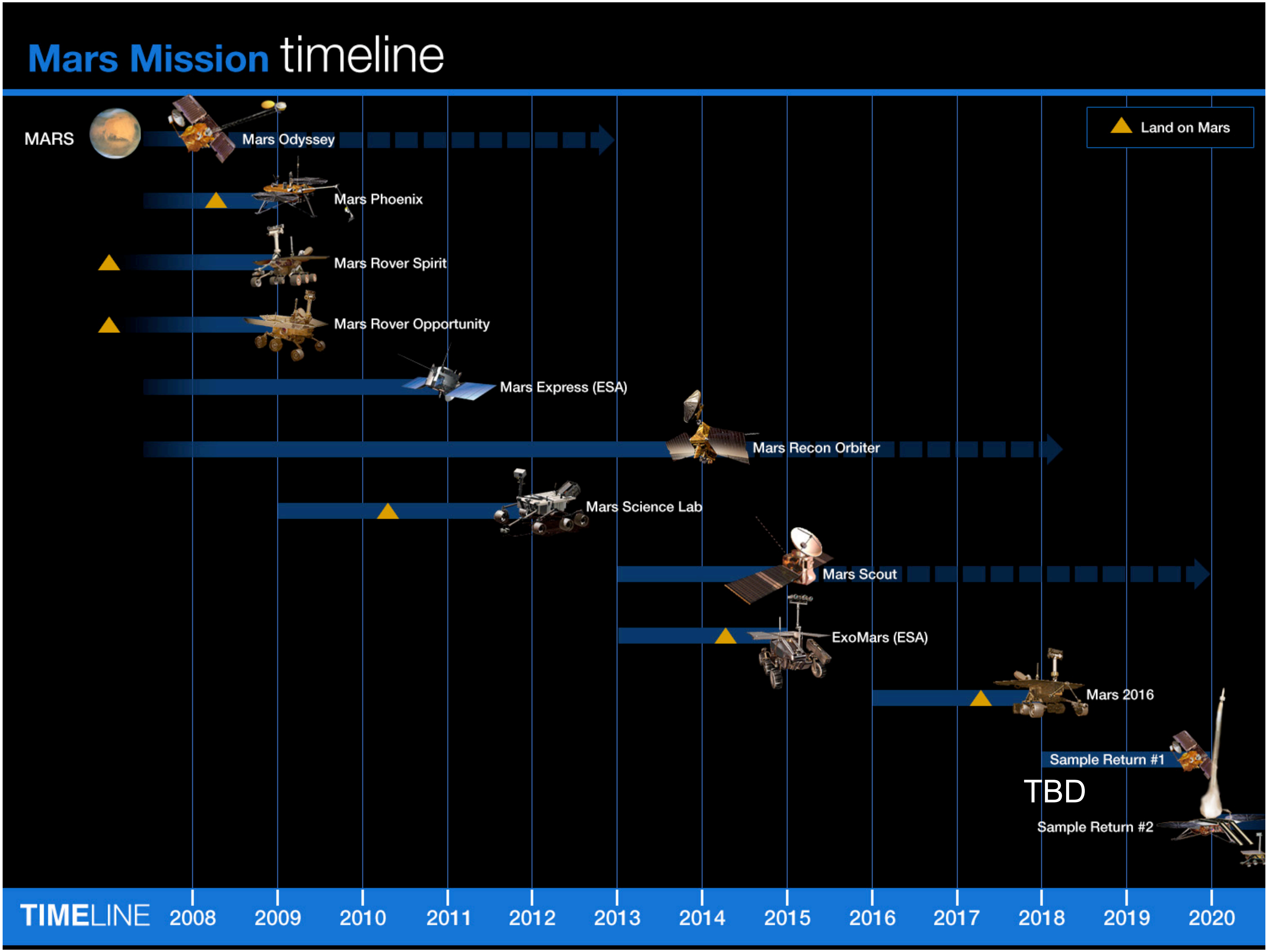


Outboard Housing and Paired ASC-Es

Paired converters with interconnect sleeve assembly

DSMCE Selections

Baines, Kevin	JPL	Venus	Aerial Vehicle	Polar VALOR: The Feasibility of A Nuclear-Powered Long-Duration Balloon Mission to Explore the Poles of Venus
Elphic, Richard	Los Alamos National Laboratory	Moon	Lander	Locating and Characterizing Lunar Polar Volatiles: Feasibility of a Discovery-Class Mission
Jolliff, Bradley	Washington University	Moon	Rover	Journey to the land of Eternal Darkness and Ice (JEDI): A Lunar Polar Volatile Explorer
Rivkin, Andrew	Applied Physics Lab	Asteroid	Lander	Ilion: An ASRG-Enabled Trojan Asteroid Mission Concept
Hecht, Michael	JPL	Mars	Lander	A tour through Martian history: An ASRG-powered polar ice borehole.
Stofan, Ellen	Proxemy Research	Outer Planets	Lander	Titan Mare Explorer (TiME)
McEwen, Alfred	University of Arizona	Outer Planets	Orbiter	Mission Concept: Io Volcano Observer (IVO)
Sandford, Scott	NASA/AMES	Comet	Sample Return	Concept Study for a Comet Coma Rendezvous Sample Return Mission
Sunshine, Jessica	Univeristy of Maryland	Comet	Lander	Comet Hopper


Mars Mission timeline
MARS
Land on Mars
Mars Odyssey
Mars Phoenix
Mars Rover Spirit
Mars Rover Opportunity
Mars Express (ESA)
Mars Recon Orbiter
Mars Science Lab
Mars Scout
ExoMars (ESA)
Mars 2016
Sample Return #1
TBD
Sample Return #2
TIMELINE
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

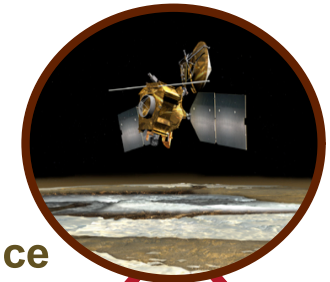
Mars Exploration Approach

A CONNECTED SET OF MISSIONS

RESPONSIVE to DISCOVERIES

SEEK

Orbital and Airborne Reconnaissance



- Where to look
- The context
- Foundation datasets
- Finding safe landing sites
- Comm infrastructure

SAMPLE

Return rock and soil samples

Mars Systems Science: The Context for Biological Potential

IN-SITU

(surface) Experiments and Reconnaissance

- Ground-truthing
- Surface reconnaissance
- Seeing under the dust
- Subsurface access

- Definitive testing of hypotheses
- Experiments to test biological potential

New Frontiers Program

1st NF mission
<u>New Horizons:</u>

Pluto-Kuiper Belt Mission

Launched January 2006
Arrives July 2015

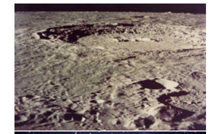
2nd NF mission
<u>JUNO:</u>

Jupiter Polar Orbiter Mission

August 2011 launch

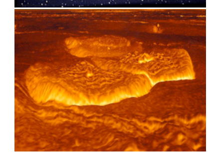
3rd NF mission opportunity

South Pole Aitken Basin Sample Return

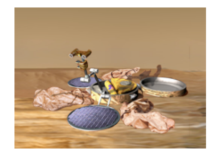


Comet Surface Sample Return (CSSR)

Venus In Situ Explorer (VISE)



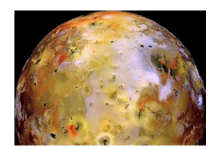
Network Science



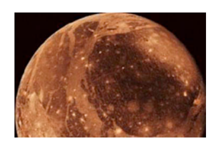
Trojan/Centaur

Asteroid Sample Return

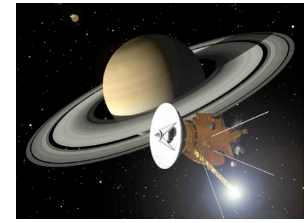
Io Observer

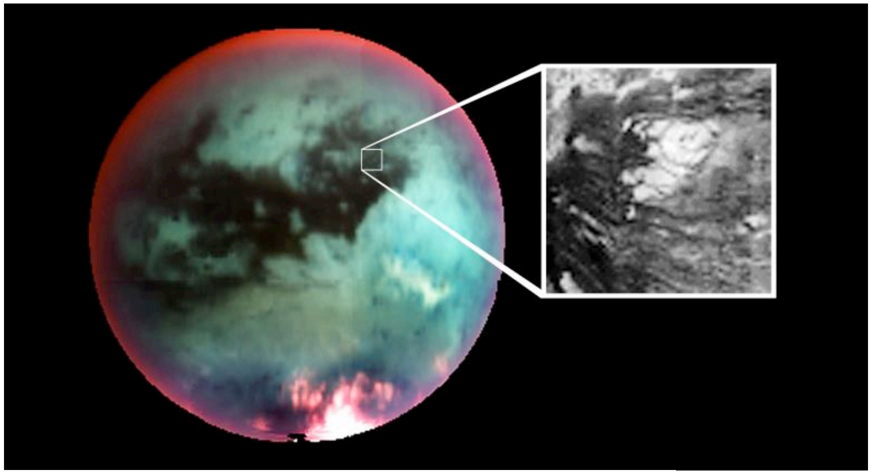


Ganymede Observer

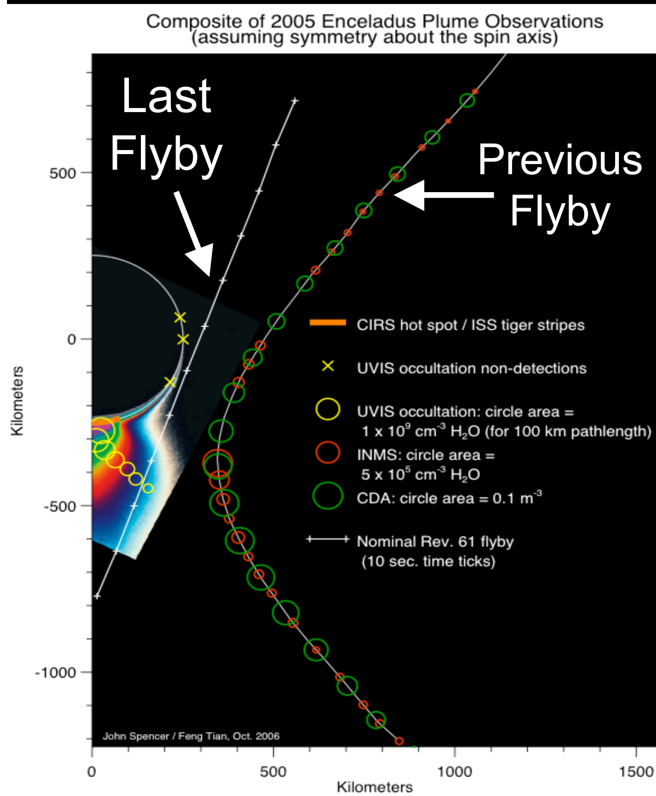


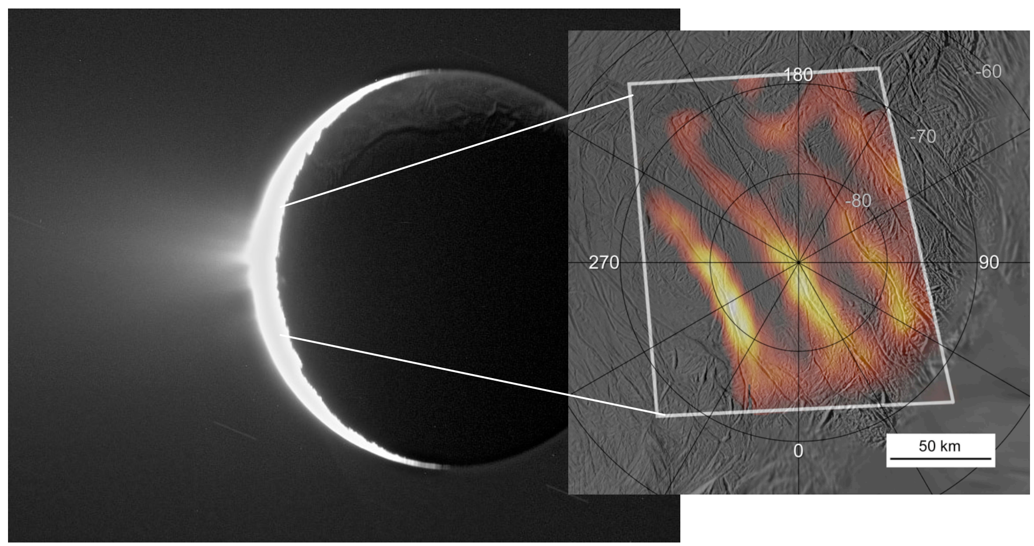
Cassini-Huygens



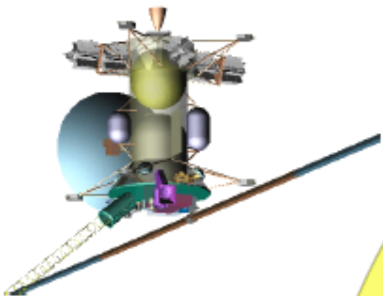


- Detailed orbital investigation of Saturn, rings, magnetosphere, Titan, and icy satellites
- Launched: October 15, 1997
- Saturn arrival: July 1, 2004
- Huygens probe at Titan: Jan. 14, 2005
- 4 yrs primary mission with 2 yrs extension

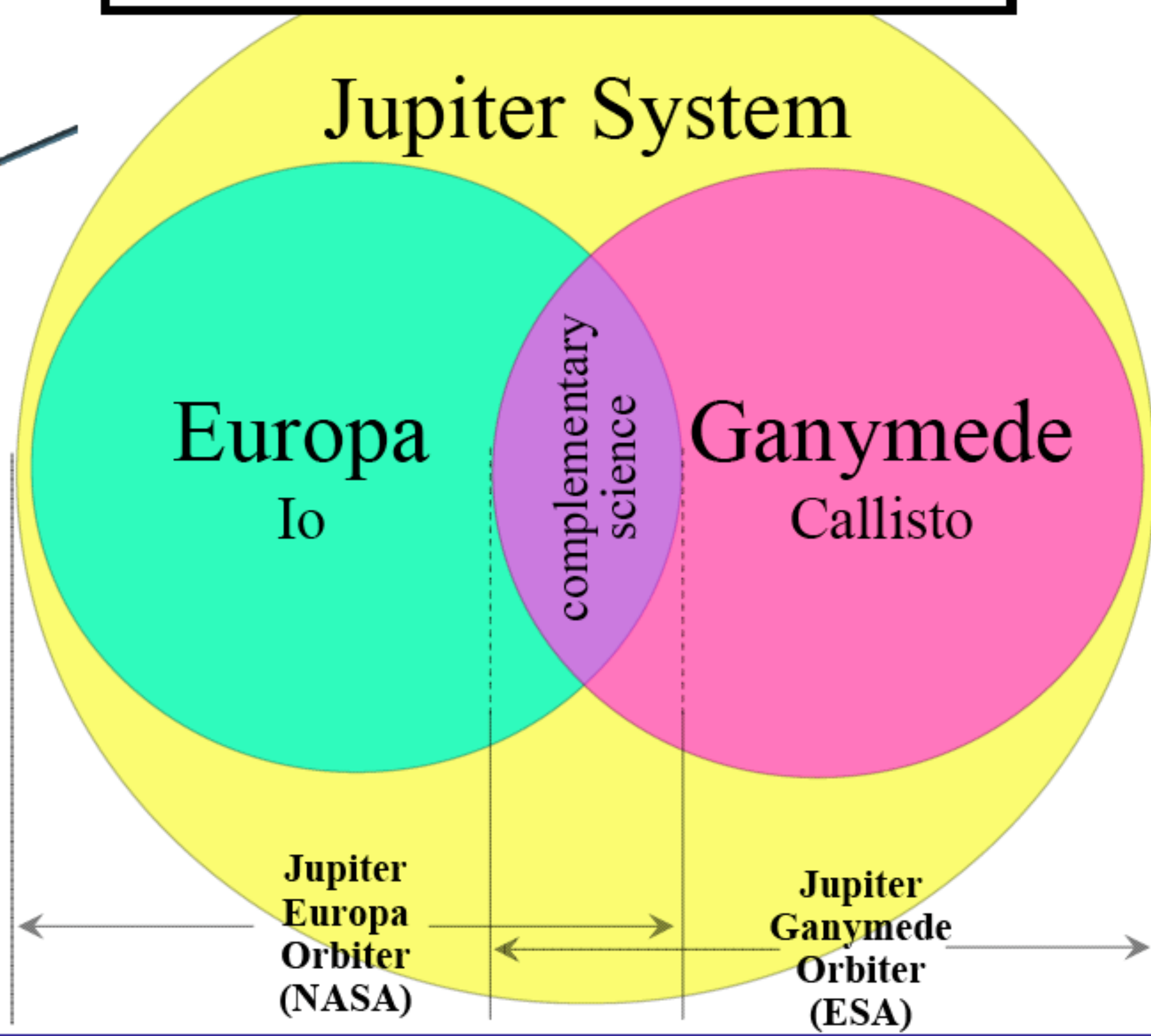




The Emergence of Habitable Worlds Around Gas Giants



NASA Jupiter Europa Orbiter (JEO)



ESA Jupiter Ganymede Orbiter (JGO)

JAXA Jupiter Magnetospheric Orbiter (JMO)

JEO is designed to stand alone or operate synergistically with ESA JGO

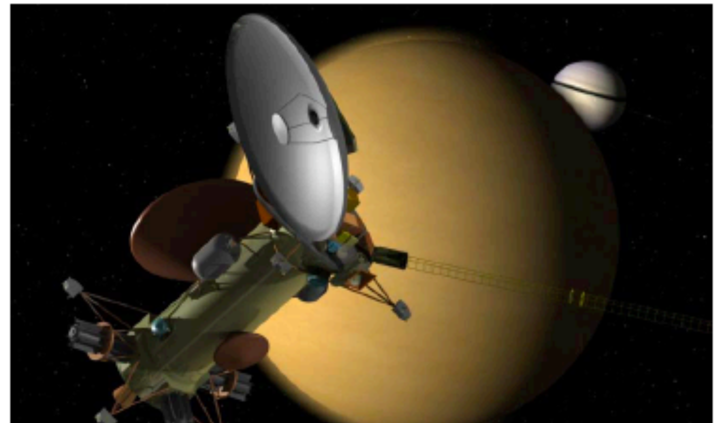
Titian Core Mission Overview

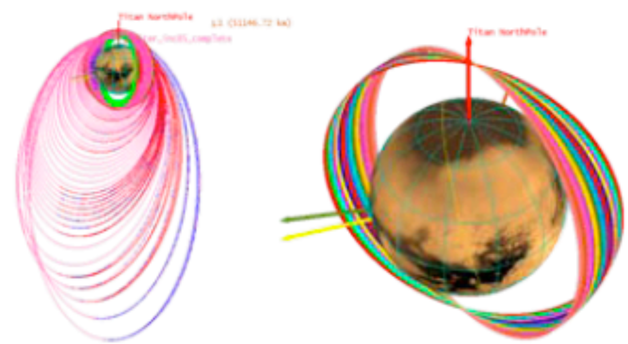
- **Objective: Titan orbit, Saturn system and Enceladus**

- **Orbiter accommodates ESA provided in situ elements;**
  - Core mission includes lander
  - Sweet spot and Enhanced missions include both lander and Montgolfiere but exceed study cost cap

- **Mission Timeline:**
  - Launch 9/2016
  - Saturn Arrival 9/2026
  - Saturn Tour; includes 4 Enceladus and 15 Titan flybys
  - Dedicated Titan aerosampling and mapping Orbit

- **Focused payload; 6 inst. + RSA**

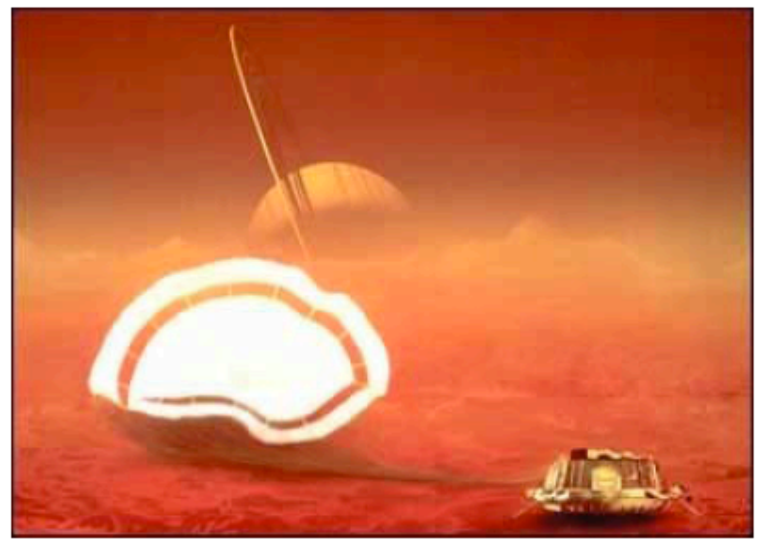




ESA Provided *In situ* elements

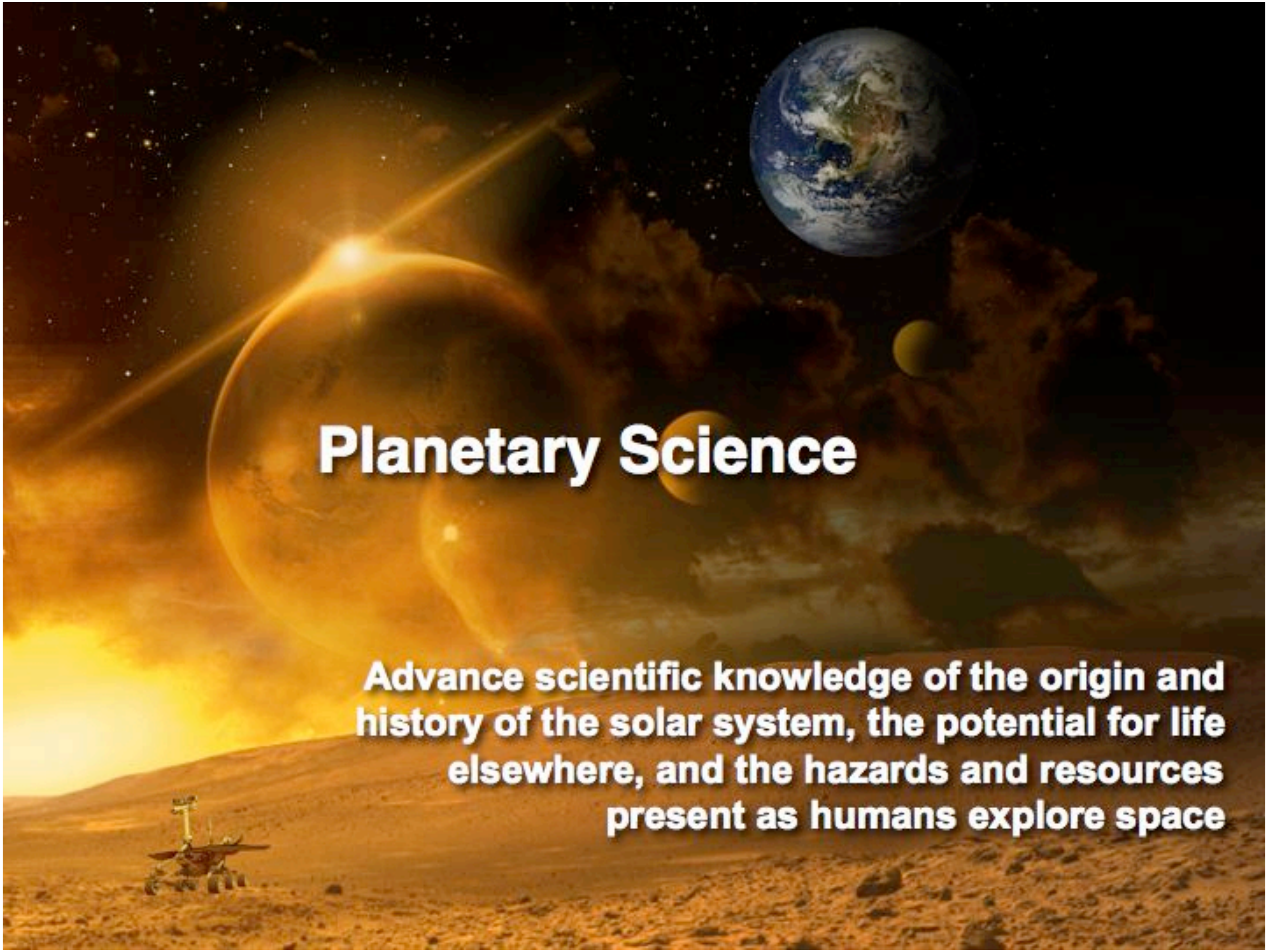
- **Montgolfiere Balloon**
  - Release 6 months prior to arrival; <6km/s
  - Near equatorial to mid latitude location
  - Relay to orbiter and Direct to Earth (DTE) in Saturn tour; relay after TOI
  - Floats at 10km (+2 -8 km) altitude
  - Circumnavigates the globe
  - Lower atmosphere and surface science
  - > 6 months earth year life science reqmt
- **Capable Lander**
  - Would land in lake or dry lake bed at northern latitudes, or mid latitude
  - Very similar entry conditions to balloon
  - Similar relay options to balloon
  - Surface, hydrology and interior science
  - >1 earth month (2 Titan days) life for dry landing
    - >1 hours lake landing, battery power


"Around Titan in 80 Days", Tokano



Mission Architectures Trends

- Continue with flyby and orbit as initial steps
- Will see more multi-element missions for specific planetary bodies
  - Lander/rovers will require orbiting assets
  - Sample return
- Development and use of key technologies
  - In-space propulsion systems
  - Radio isotope power system
- Will require more heavy left capability
- Take advantage of coordinating multi-agency missions


Planetary Science
Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space